APPLICATIONS FOR ELASTIC LAMINATE WEB

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CROSS REFERENCE TO RELATED APPLICATIONS

This application is: a continuation-in-part and claims priority of prior application PCT International Application Serial No. US00/34746 (Case 7897R2) which designates the US, will publish in English, and was filed December 20, 2000 in the names of Curro et al.; and a continuation-in-part and claims priority of prior application Serial No. 09/584676 (Case 7897R2), filed May 31, 2000 in the names of Curro et al.; and a continuation-in-part and claims priority of prior application Serial No. 09/467938 (Case 7897), filed December 21, 1999 in the names of Curro et al.

FIELD OF THE INVENTION

This invention relates to an extensible multilayer laminate web, and more particularly to a laminate web wherein at least an elastic layer is extensible and apertured. In some embodiments the entire multilayer laminate web is extensible, elastic, and apertured.

BACKGROUND OF THE INVENTION

Laminate webs formed by the joining of discrete webs in a layered relationship are well known in the art. For example, laminate nonwoven webs are often utilized in disposable absorbent articles such as diapers and adult incontinence products. Such laminated webs can be used as a topsheet, backsheet, or side panels. One example of a laminate web is a film/nonwoven laminate useful as a backsheet of a disposable diaper. Nonwoven/nonwoven laminates are also utilized to provide additional bulk or softness to a web component. Likewise, film/film laminate webs can provide benefits by combining the characteristics of various films in a layered relationship. Laminate webs can also be called composite webs.

Often laminate webs are intended to combine properties of the constituent layers to achieve synergistic benefits. For example, elastic materials can be combined with

nonwoven webs to form elastically extensible nonwoven webs. Such materials can exhibit a plurality of gathers, or rugosities, when in a relaxed state. Elastic composite webs are useful as elastic waist portions, or stretch ear portions of disposable absorbent articles.

For many applications of laminate webs, it is beneficial to have apertures therethrough. Apertures add texture, which contributes to utility as well as aesthetics. For example, as a cleaning wipe, a laminate with apertures can capture and hold dirt better than a wipe without apertures.

A beneficial method of aperturing a nonwoven web, including laminates of nonwoven webs is disclosed in EP-A-852,483, issued to Benson et al. Disclosed is a laminate material having, for example, at least one layer of a spunbonded web joined to at least one layer of a meltblown web, a bonded carded web, or other suitable material. Such apertured webs are useful as the topsheet in a disposable absorbent article. However, this disclosure does not teach laminating webs comprising elastomeric materials to make an elastically extensible apertured web.

A perforated multilayer elastic coversheet comprising an intermediate elastic layer between upper and lower nonwoven layers is disclosed in EP-A-784,461 issued to Palumbo. The upper and lower layers are connected to the intermediate layer only around the perimeters of the perforations. While providing an apertured, elastic laminate, it is not apparent that the method disclosed could produce elastic laminates economically. It is also not apparent that the elastic laminate would be elastically extensible in more than one direction.

Accordingly, it would be desirable to have an elastically extensible apertured nonwoven web, the apertured web being characterized by a plurality of openings, or perforations, in the web, and being elastically extensible in at least two directions.

Further, it would be desirable to have an economically attractive method for making an elastically extensible apertured nonwoven web.

BRIEF SUMMARY OF THE INVENTION

An elastic laminate web is disclosed. The elastic laminate web can be non-apertured or apertured, and comprises a first web, and a second web joined to the first

web in a face to face relationship at a plurality of discrete bond sites having an aspect ratio of at least 2. The first and second webs form an interior region therebetween. An elastic material is disposed between the first and second webs. The elastic material is apertured in regions coincident the bond sites, such that the first and second webs are joined through the apertures. The laminate produced can be stretched in a predetermined direction, such as by incremental stretching, to produce an apertured elastic laminate. Also disclosed are mattress covers and other applications in which the elastic laminate web may be used.

One method for forming the elastic laminate web of the present invention comprising the steps of:

(a) providing first and second web materials comprising thermoplastic material;

(b) providing at least one third elastomeric web material;

(c) providing a thermal point bonder having a plurality of protuberances;

(d) guiding the third elastomeric web material in a stretched condition between the first and second web materials in a face-to-face layered relationship to the thermal point bonder;

(e) displacing the third elastomeric web material with the protuberances at discrete, spaced apart locations to form apertures in the third material; and

(f) thermally point bonding the first and second outer web materials to form bond sites at discrete, spaced apart locations coincident with the protuberances, thereby forming a bonded laminate.

To make an apertured elastic web, the method comprises the additional step of:

(g) stretching the bonded laminate to form apertures in the elastomeric laminate web.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims pointing out and distinctly claiming the present invention, it is believed the same will be better understood by the following drawings taken in conjunction with the accompanying specification wherein like components are given the same reference number.

FIG. 1 is a perspective of one embodiment of a laminate web of the present invention.

FIG. 2 is a cross-sectional view of a portion of the laminate web shown in Figure 1.

FIG. 3 is a magnified detail view of one bond site of a laminate web of the present invention.

FIG. 4 is a top plan view of another embodiment of the laminate web of the present invention.

FIG. 5 is a cross-sectional view of a portion of the laminate web shown in Figure 4.

FIG. 6 is a top plan view of another embodiment of the laminate web of the present invention.

FIG. 7 is a cross-sectional view of a portion of the laminate web shown in Figure 6.

FIG. 8 is a photomicrograph of one embodiment of a laminate web of the present invention.

FIG. 9 is a schematic representation of a process for making a laminate web of the present invention.

FIG. 10 is a perspective view of a melt bond calendaring apparatus.

FIG. 11 is a schematic representation of a pattern for the protuberances of the calendaring roll.

FIG. 12 is a perspective view of an apparatus for stretching a laminate of the present invention to form apertures therein.

FIG. 13 is a cross-sectional view of a portion of the mating portions of the apparatus shown in FIG. 12.

FIG. 14 is a perspective view of an alternative apparatus for stretching a laminate of the present invention in the cross-machine direction to form apertures therein.

FIG. 15 is a perspective view of another alternative apparatus for stretching a laminate of the present invention in the machine direction to form apertures therein.

FIG. 16 is a perspective representation of an apparatus for stretching a laminate of the present invention in both the cross-machine and machine directions to form apertures therein.

DETAILED DESCRIPTION OF THE INVENTION

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As used herein, the term "absorbent article" refers to devices which absorb and contain body exudates, and, more specifically, refers to devices which are placed against or in proximity to the body of the wearer to absorb and contain the various exudates discharged from the body. The term "disposable" is used herein to describe absorbent articles which are not intended to be laundered or otherwise restored or reused as an absorbent article (i.e., they are intended to be discarded after a single use and, preferably, to be recycled, composted or otherwise disposed of in an environmentally compatible manner). A "unitary" absorbent article refers to absorbent articles which are formed of separate parts united together to form a coordinated entity so that they do not require separate manipulative parts like a separate holder and liner.

As used herein, the term "nonwoven web" is used in its plain meaning as understood in the art and refers to a web that has a structure of individual fibers or threads which are interlaid, but not in any regular, repeating manner. Nonwoven webs have been, in the past, formed by a variety of processes, such as, for example, meltblowing processes, spunbonding processes and bonded carded web processes.

As used herein, the term "microfibers", refers to small diameter fibers having an average diameter not greater than about 100 microns.

As used herein, the term "meltblown fibers", refers to fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g., air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter, which may be to a microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers.

As used herein, the term "spunbonded fibers", refers to small diameter fibers which are formed by extruding a molten thermoplastic material as filaments from a plurality of fine, usually circular, capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced by drawing.

As used herein, the term “unitary web” refers to a layered web comprising two or more webs of material, including nonwoven webs, that are sufficiently joined, such as by thermal bonding means, to be handled, processed, or otherwise utilized, as a single web.

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As used herein, "laminate" and "composite" when used to describe webs of the present invention, are synonymous. Both refer to a web structure comprising at least two webs joined in a face to face relationship to form a multiple-layer unitary web.

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiaotactic and random symmetries.

As used herein, the term "elastic" refers to any material which, upon application of a biasing force, is stretchable, that is, elongatable, at least about 60 percent (i.e., to a stretched, biased length, which is at least about 160 percent of its relaxed unbiased length), and which, will recover at least 55 percent of its elongation upon release of the stretching, elongation force. A hypothetical example would be a one (1) inch sample of a material which is elongatable to at least 1.60 inches, and which, upon being elongated to 1.60 inches and released, will recover to a length of not more than 1.27 inches.

Many elastic materials may be elongated by more than 60 percent (i.e., much more than 160 percent of their relaxed length), for example, elongated 100 percent or more, and many of these materials will recover to substantially their initial relaxed length, for example, to within 105 percent of their initial relaxed length, upon release of the stretch force. Such materials are denoted herein by the term "highly elastic" which refers to any material which upon application of a biasing force, is stretchable, that is, elongatable, at least about 200 percent (i.e., to a stretched, biased length, which is at least about 300 percent of its relaxed unbiased length), and which, will to within 105 percent of their initial relaxed length, upon release of the stretch force. Therefore, highly elastic materials are generally also elastic, but not all elastic materials are highly elastic.

As used herein, the term "nonelastic" refers to any material that does not fall within the definition of "elastic" above.

As used herein, the term "extensible" refers to any material which, upon application of a biasing force, is elongatable, at least about 25 percent without experiencing catastrophic failure. Catastrophic failure includes substantial tearing,

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fracturing, rupturing, or other failure in tension such that, if tested in a standard tensile tester, the failure would result in a sudden significant reduction in tensile force. As used herein, the term "highly extensible" refers to any material which, upon application of a biasing force, is elongatable, at least about 100 percent without experiencing catastrophic failure.

The Laminate Web

The laminate web **10** of the present invention comprises at least three layers or plies, disposed in a layered, face-to-face relationship, as shown in FIG. 1. The layers should be sufficiently thin to be processible as described herein, but no actual thickness (i.e., caliper) is considered limiting. A first outer layer **20**, is preferably thermally bondable, and is preferably a nonwoven web comprising a sufficient quantity of thermoplastic material, the web having a predetermined extensibility and elongation to break. By "sufficient quantity" is meant a quantity of thermoplastic material adequate to enable enough thermal bonding upon application of heat and/or pressure to produce a unitary web. A second outer layer, **40**, is preferably the same material as first outer layer **20**, but may be a different material, also being thermally bondable and having a predetermined extensibility and elongation to break. At least one elastomeric elastic layer **30** is disposed between the two outer layers. The laminate web **10** is processed by joining means, such as by ultrasonic welding, or thermal calendaring as described below to provide a plurality of melt bond sites **50** that serve to couple the outer layers **20** and **40**, and, in some embodiments, portions of elastic layer **30**, thereby forming the constituent layers into a unitary web. When joined together, the two outer layers form an interior region between them. The interior region is the space between the outer layers surrounding the bond sites **50**. In a preferred embodiment, the elastic layer **30** substantially fills the interior region, the elastic layer **30** being apertured coincident the bond sites **50**.

While the laminate web **10** is disclosed primarily in the context of nonwoven webs and composites, in principle outer layers **20** and **40** of the laminate web **10** can be made out of any web materials that meet the requirements, (*e.g.*, melt properties, extensibility) as disclosed herein. For example, the outer layers **20** and **40** can be thermoplastic films,

micro-porous films, apertured films, a woven fabric, and the like. In general, it is required that outer layer materials be flexible enough to be processed as described herein.

Non-Apertured Embodiment

In one embodiment, as shown in cross-section in FIG. 2, elastic layer **30** can be apertured, without aperturing the two outer layers to provide a three-layer laminate characterized by the laminate web **10** (as a whole) being un-apertured, while the elastic layer **30** is apertured. Importantly, the web of the present invention can be made by the method of the present invention without requiring registration of the layers to ensure bonding of the outer layers through the apertures of the elastic layer(s). One way of describing a preferred embodiment of a web **10** as described above, is that the unitary web **10**, when viewed orthogonally by the un-aided human eye from a distance of approximately 50 cm, exhibits no apertures or perforations through the entire laminate, but bond sites **50** are nevertheless visible.

The laminate web **10** is further characterized in that the joining of the three plies into a unitary web can be achieved in the absence of adhesive. That is, in certain preferred embodiments no adhesive is required to bond the plies together; joining is achieved by the input of energy into the constituent layers, such as by thermal melt bonding of the two outer layers together at the melt bond sites **50**. In other embodiments, the energy input can be via ultrasonic bonding. Accordingly, a significant benefit of the present invention is the provision of an elastic laminate web, that is a unitary web formed without the use of adhesives. Not only does this simplify processing and lower the cost of the elastic laminate web, when certain materials such as nonwoven webs are used, it results in a more flexible, softer web.

As shown in FIG. 2, elastic layer **30** is chosen such that when the constituent web layers of laminate web **10** are processed by the method of the present invention, portions of elastic layer **30** in the region of the melt bond sites **50** separate to permit the first outer layer **20** to melt bond directly to the second outer layer **40** at the interface of the two materials **52** at melt bond sites **50**. Thus, apertures in the elastic layer **30** are formed in the lamination step by displacement, just prior to the bonding of the outer layers as detailed by the method of the present invention below. In this manner, elastic layer **30**

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can be provided as an unapertured web, avoiding complex registration steps to align apertures in registry with bond sites when laminated. Further, elastic layer **30** need not be thermally compatible with outer layers **20** and **40**. Elastic layer **30** need not be a thermoplastic material, and need not even have a melting point. It simply needs to be displaceable by the forces exerted by the processing equipment as detailed below. The elastic layer can be a thermoset material with no melting point. If it has a melting point, it is preferably at least about 10 degrees Centigrade higher, more preferably about 20 degrees Centigrade higher than either outer layer.

Another advantage of the method of the present invention is that, in some embodiments, e.g., for solid core elastic layer **30** materials (i.e., a continuous sheet, that is, not having substantial apertures, gaps, or other voids), it results in a unitary web having an apertured elastic layer **30** in full, intimate contact with the outer layers **20**, and **40**. By "full" and "intimate" is meant that elastic layer **30** fills all the unbonded regions between outer layers **20** and **40** such that outer layers **20** and **40** do not contact except at the bond sites **50**. Of course, it is recognized that some elastic materials of interest have significant air content (e.g., elastic nonwoven materials), and filling "all" the unbonded region between outer layers **20** and **40** is not meant to imply that all air content is removed.

The elastic layer **30** can be stretched in at least one direction before outer layers **20** and **40** are bonded to one another, i.e., either in the **MD** or **CD** direction.. For example, as shown below with reference to the method for making, elastic layer **30** can be stretched in the machine direction **MD** prior to the laminate web being bonded into a unitary web. In this manner, an elastic composite is produced. Once the tension is removed from the elastic layer **30** it can freely retract to an untensioned state, and the two outer layers **20** and **40** become gathered, giving good three-dimensional puckering in a direction generally orthogonal to the direction of extension.

Elastic layer **30** can be involved, or participate, in the bonding between outer layers **20** and **40**. By "involved" is meant that the elastic layer can, to some extent, be in intimate contact with, and possibly partially merged with, one or both immediate outer layers. The involvement may be due to actual melt bonding about the perimeter of bond site **50** (e.g., for thermoplastic elastic layers **30**), or it may be due to mechanical

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interaction, such as by entanglement (e.g., for a fibrous elastic layer **30** between fibrous nonwoven layers), also about the perimeter of bond site **50**.

Without being bound by theory, it is believed that the process of the present invention facilitates such separation of elastic layer **30** by shearing, cutting, or otherwise fracturing the elastic layer **30**, and displacing the material of the elastic layer **30** sufficiently to permit thermal bonding of the two outer layers **20** and **40**. Thus, elastic layer **30** must be chosen to have properties that permit such displacement. Importantly, it is not required that the elastic layer **30** be melted out of the region of the thermal bond sites. Elastic layer can be elastic or highly elastic depending on the desired end results and purposes of the resulting unitary web.

Without being bound by theory, it is believed that to accomplish the displacement of elastic layer **30** to form apertures therein and to bond the outer layers, the thermal point calendaring described below should form thermal bond sites having a narrow width **W** dimension and a high aspect ratio. For example, FIG. 3 shows the melt area of a single melt bond site **50** having a narrow width dimension **W** and a high aspect ratio, *i.e.*, the length, **L**, is much greater than the width, **W**. The length **L** should be selected to permit adequate bond area while width **W** is sufficiently narrow such that the protuberance used to form the bond site (as described below) can cut, shear, displace, or otherwise pierce the elastic layer **30** at the region of the bond sites by the method described below. Width **W** can be between about 0.003 inches and 0.020 inches, but in a preferred embodiment, is between about 0.005 inches and 0.010 inches, and may be adjusted depending on the properties of elastic layer **30**.

It is believed that the aspect ratio of melt bond site **50** can be as low as about 2 (i.e., ratio of **L/W** equals 2/1). It can also be between about 3 and 100 or between about 3 and 50 or preferably between about 4 and 30. In one preferred embodiment, the aspect ratio was about 10 and in other embodiment about 25. It is believed that the aspect ratio of the melt bond sites **50** is limited only by the corresponding aspect ratio of the point bonding protuberances of the calendaring roller(s), as detailed below.

In a preferred embodiment, the longitudinal axis of each bond site, **l**, which corresponds directionally to the length dimension of bond site **50**, is disposed in a regular, repeating pattern oriented generally parallel to the machine direction, **MD** as shown in

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FIG. 1. But the longitudinal axis of each bond site may be disposed in a regular, repeating pattern oriented in the cross machine direction, or randomly oriented in a mixture of cross and machine directions. For example, the bond sites **50** can be disposed in a "herringbone" pattern.

When nonwoven webs are used as constituent layers of laminate **10**, an important distinction should be drawn between bond sites **50** which bond together outer layers **20** and **40** by the method of the present invention, and thermal bond sites that may be present in the constituent layers themselves. For example, nonwoven webs are typically consolidated by thermal bonding in a regular pattern of discrete spaced apart fused bonding areas, such as the pattern disclosed in U.S. Pat. No. 3,855,046 to Hansen et al., and the patterns shown generally in FIGs. 10 and 11 of U.S. patent 5,620,779 to Levy et al. Other films, nonwoven webs, and the like may have thermal embossments for aesthetic reasons. Therefore, as shown in FIG. 18, in the unitary web **10** there may be many thermal bond sites, some of which are bond sites **50**, and others which are bond sites in the base nonwoven (diamond shaped sites), for example.

The bond sites of the base nonwoven do not typically have an aspect ratio greater than about 1, so that these bonds do not typically form apertures in the constituent layer during the stretching step disclosed below. Also, the spacing of such bond sites is typically a repeating pattern of bonded and unbonded area which may or may not provide for machine direction (MD) columns of bonded area next to columns of unbonded area. After forming bond sites **50**, however, there is not likely to be any significant MD columns of unbonded areas; the overall bond pattern of any constituent nonwoven fabric is a combination of existing bonded areas and bond sites **50**. As shown in FIG. 18, together the two sets of bond sites result in a complex pattern of bond sites that may or may not be described as columnar, regular, or uniform.

The resulting web of the present invention, as shown in cross-section in FIG. 2, is a laminate web **10** that is itself unapertured, but the elastic layer **30** is apertured coincident the regions of the bond sites **50**. As stated above, by "unapertured" is meant that, on the whole, the laminate web **10** is considered unapertured. It is recognized that the un-apertured laminate web **10** of the present invention may have localized cut through, or tearing at bond sites **50** due to materials and processing variability or post lamination

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handling. Ideally, such cut through of the entire web is minimized and eliminated. Likewise, it is recognized that in some instances, there may not be complete displacement of the elastic layer **30** at all locations of bond sites **50** such that some localized portions of elastic layer **30** may not be apertured (and the outer layers not bonded). Nevertheless, the description herein is made for the laminate web **50** as a whole, and is not meant to be limited by aberrations or anomalies due to potential material or processing variables.

To produce the webs of the present invention, including as described with reference to FIG. 2, the outer layers should have sufficient elongation to permit the necessary local deformation in the immediate vicinity of bond sites **50**. Thus, the outer layers **20** and **40** can be extensible, highly extensible, elastic, or highly elastic.

The elastic layer **30** itself need not be thermally compatible with the outer layers. The elastic layer **30** need not even be melt processible. It can be, for example, a thermoset material, such as a polyester elastomeric film, such as elastomeric Hytrel® from DuPont. The elastic layer **30** can be another nonwoven having suitable properties for processing into an apertured layer. If elastic layer **30** has a melting point, it is preferably at least about 10 degrees Centigrade higher, more preferably about 20 degrees Centigrade higher than the outer layers. However, elastic layer **30** need not have a melting point, and may simply experience softening at the calendaring temperatures required to bond the laminate.

A further benefit of the present invention is the capability to combine both thermoplastic and non-thermoplastic materials without any adhesives, to provide fabric-like composites having elastomeric properties. For example, many elastic materials, including elastomeric films or similar materials are not soft and clothlike, but have the look and feel of a plastic film, often a tacky film. When used in a laminate web **10** of the present invention, for example with nonwoven outer layers, the elastic laminate web can exhibit the softness of a nonwoven with the elasticity of an elastomer. Again, this laminate can be, and is preferably, made without the use of adhesives to bind the web into a unitary web.

<u>Apertured Embodiments</u>

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A further benefit of the present invention is obtained when the non-apertured thermally bonded laminate web described above is stretched or extended in a direction generally orthogonal to the longitudinal axis, **l**, of melt bond sites **50**. The melt bonding at the melt bond sites **50** tends to make localized weakened portions of the web at the bond sites. Thus, as portions of the web **10** are extended in a direction generally orthogonal to the longitudinal axis **l** of bond sites **50** (i.e., in the CD direction as shown in FIG. 1), the material at the bond site fails in tension and an aperture is formed. The relatively high aspect ratio of melt bond sites **50**, permits a relatively large aperture to be formed upon sufficient extension. When the laminate web **10** is uniformly tensioned, the result is a regular pattern of a plurality of apertures **60** corresponding to the pattern of melt bond sites **50**.

FIG. 4 shows a partially cut-away representation of an apertured laminate of the present invention. As shown, the partial cut-away permits each layer or ply to be viewed in a plan view. The laminate web **10** shown in FIG. 4 is produced after the thermally bonded laminate is stretched in a direction orthogonal to the longitudinal axis of the melt bond sites, in this case, in the cross-machine direction, **CD** with sufficient elongation in the direction of extension to cause apertures to form. As shown, where formerly were melt bond sites **50**, apertures **60** are produced as the relatively weak bond sites fail in tension. Also as shown, elastic layer **30** can remain generally uniformly distributed within laminate **10**, depending on the material properties of elastic layer **30**.

When apertures **60** are formed, the thermally bonded portions of outer layers **20** and **40** remain primarily on the portions of the aperture perimeters corresponding to the length dimension of bond sites **50**. Therefore, each aperture **60** does not have a perimeter of thermally bonded material, but only portions remain bonded, represented as **62** in FIG. 4.

To the extent that elastic layer **30** is involved, or participates, in any bonding between outer layers **20** and **40**, it also participates in the remnant of bonded portions **62**, as shown in FIG. 4. The involvement may be due to some degree of actual melt bonding about the perimeter of bond site **50** (e.g., for thermoplastic elastic layers **30**), or it may be due to mechanical interaction, such as by entanglement (e.g., for fibrous elastic layer **30** between fibrous nonwoven layers).

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FIG. 5 is a schematic representation of the cross-section denoted in FIG. 4. As shown, apertures **60** form when the laminate web is elongated in the direction **T**.

Another benefit of the present invention is obtained when the laminate is extended as described with reference to FIG. 4, but the elastic layer **30** provides a restoration force to cause a retraction of the laminate web in the cross machine direction. Thus, in this embodiment, when the elastic layer **30** is pre-tensioned as described above, and incrementally stretched in a direction generally orthogonal to the direction of pre-tension, a bi-directional stretch laminate is produced. For most elastomeric materials, the resulting laminate is effectively a multi-directional stretch laminate.

In another method, one or both webs **120** or **140** could be incrementally stretched and consolidated by stretching, to provide precursor webs that have cross direction stretch potential "built in" prior to being bonded at the thermal point bond roller arrangement **108** as shown above. Incremental stretching precursor webs **120** or **140** could can be accomplished by processing the webs through an incremental stretching system **132** as discussed above. Consolidation can be achieved by means known in the art, including stretching in the machine direction, which yields a corresponding narrowing of the width in the cross direction.

Another embodiment of a laminate web of the present invention utilizing nonwoven webs as the outer layers is characterized by distinct regions differentiated by fiber orientation. Differential fiber orientation can be achieved by providing for localized regions within the web that experience greater extension than other regions. Such localized straining is possible by the method of the present invention detailed below.

More than one type of elastic layer **30** can be used with beneficial results. For example, a elastic layer **30** can be a three-dimensional formed film. Macroscopically-expanded, vacuum-formed, three-dimensional formed film, such as described in commonly-assigned U.S. Ser. No. 08/816,106, entitled "Tear Resistant Porous Extensible Web" filed by Curro et al. on March 14, 1997, and hereby incorporated herein by reference. Further, the (or "a") elastic layer can be a three-dimensional formed film having micro-apertures such as described in commonly-assigned U.S. Pat. No. 4,629,643

issued to Curro et al. on December 16, 1986, and 4,609,518, issued to Curro et al. on September 2, 1986, both of which are hereby incorporated herein by reference.

The elastic layer can be a web material having a strainable network as disclosed in U.S. Pat. No. 5,518,801 issued to Chappell et al. on May 21, 1996, and hereby incorporated herein by reference. Such a web can be a structural elastic-like film (SELF) web, formed by, for example, embossing by mating plates or rolls.

The elastic layer **30** may comprise absorbent gelling materials. For example, supersorbers or hydrogel materials may provide for superior absorbency when the laminate web of the present invention is used as an absorbent wipe or an absorbent core in a disposable absorbent article. By "hydrogel" as used herein is meant an inorganic or organic compound capable of absorbing aqueous fluids and retaining them under moderate pressures. For good results the hydrogels should be water insoluble. Examples are inorganic materials such as silica gels and organic compounds such as cross-linked polymers. Cross-linking may be by covalent, ionic, vander Waals, or hydrogen bonding. Examples of polymers include polyacrylamides, polyvinyl alcohol, ethylene maleic anhydride copolymers, polyvinyl ethers, hydroxypropyl cellulose, carboxymethyl cellulose, polyvinyl pyridine and the like.

One benefit of the laminate of the present invention is the ability to make an elastic laminate structure without the use of adhesive for joining. Because the elastic layer of the laminate web **10** is penetrated by the protuberances of the calendaring roll at melt bond sites, it can comprise non-thermally-bondable materials. For example, an additional central layer can be laminated between outer layers **20** and **40** (in addition to the elastic layer **30**), which is non-thermally-bondable, such as absorbent layer, i.e. tissue or a superabsorbent. The plurality of melt bond sites **50** are sufficient to keep the component webs together in the laminate web, so that the laminate web behaves as a unitary web for processing integrity and use, without unwanted delamination. However, in some embodiments, and for certain materials, it may be beneficial to apply adhesive between at least two of the constituent layers.

The elastomeric laminate web of the present invention, being bonded by a plurality of relatively closely spaced thermal bond sites (without the use of thermoplastic adhesives) can be beneficially used for durable articles. For example, a laminate web of

the present invention comprising nonwoven web outer layers and having a clothlike feel and appearance, can be used in durable garments. Certain embodiments of the laminate web of the present invention can survive repeated washing and drying in household washing and drying equipment, depending on the component webs of the laminate, and the level of thermal bonding. Due to the knit-like or fabric-like look and feel of certain embodiments of the present invention, such durability can result in durable articles such as drapes, upholstery, and garment components such as interliners and the like.

METHOD OF MAKING

Referring to FIG. 9 there is schematically illustrated at **100** a process making a laminate web of the present invention.

A first web **120** which can be a relatively extensible web, is unwound from a supply roll **104** and travels in a direction indicated by the arrows associated therewith as the supply roll **104** rotates in the direction indicated by the arrows associated therewith. Likewise a second web **140**, which can be a relatively extensible web is unwound from supply roll **105**. An elastic layer **130** is likewise drawn from supply roll **107**. The three components (or more, if more than one central layer is used) pass through a nip **106** of the thermal point bond roller arrangement **108** formed by rollers **110** and **112**.

Prior to passing through nip **106**, elastic layer **130** is tensioned to a predetermined amount by the stacked S-wrap roller arrangement **135** as known in the art. S-wrap roller arrangement **135** retards the linear velocity of the web **130**, which is consequently stretched by the pull of the remaining line components, such as bond roller arrangement **108**, as described below. Any method known in the art can be used to achieve a stretched elastic layer **130**. In general, it is desirable to achieve at least about 10% elongation or more, or about 50% to about 150% elongation for elastic layer **130** as it enters nip **106**.

In one embodiment all constituent layers **120**, **130**, and **140** are of the same width, measured in the cross direction. However, in another embodiment, elastic layer **130** can be significantly less wide than either of the other two layers **120** or **140**. In this embodiment, elastic layer **130** would result in a relatively narrow band or strip of elastic layer **30** in finished elastic web **10**. In another embodiment a plurality of bands or strips

of elastic layer **130** can be provided, resulting in an elastic web **10** having a plurality of elastic band layers **30**.

In addition to thermoplastic nonwoven materials, either outer layer can comprise a polymeric film, for example a polyolefinic (e.g., PP or PE) thin film. If the entire outer layer is not uniformly thermoplastic, at least sufficient amounts to effect melt bonding must be thermoplastic. Conjugate fibers, such as bicomponent fibers can be used in the outer layers to facilitate thermal bonding of the outer layers. Either outer layer can comprise a formed film, such as a three-dimensional formed film having micro-apertures such as described in commonly-assigned U.S. Pat. No. 4,629,643 issued to Curro et al. on December 16, 1986, and 4,609,518, issued to Curro et al. on September 2, 1986, both of which are hereby incorporated herein by reference.

In a preferred embodiment, both outer layers comprise nonwoven materials, and may be the identical. The nonwoven material may be formed by known nonwoven extrusion processes, such as, for example, known meltblowing processes or known spunbonding processes, and passed directly through the nip **106** without first being bonded and/or stored on a supply roll. However, in a preferred embodiment, the nonwoven webs are themselves thermally point bonded (consolidated) webs commercially available on supply rolls. The thermal point bonds, which are typically in the form of a regular pattern of spaced-apart diamond shaped bond sites, are present in the nonwoven as purchased from a nonwoven vendor, and are to be distinguished in the web of the present invention from the bond sites **50** formed by the method of the present invention.

The nonwoven web outer layer(s) may be elastic, highly elastic or nonelastic. The nonwoven web may be any melt-fusible web, including a spunbonded web, a meltblown web, or a bonded carded web. If the nonwoven web is a web of meltblown fibers, it may include meltblown microfibers. The nonwoven web may be made of fiber forming polymers such as, for example, polyolefins. Exemplary polyolefins include one or more of polypropylene, polyethylene, ethylene copolymers, propylene copolymers, and butene copolymers. The nonwoven web can have a basis weight between about 10 to about 100 grams per square meter (gsm), and more preferably about 15 to about 30 gsm.

The nonwoven web outer layers may themselves be a multilayer material having, for example, at least one layer of a spunbonded web joined to at least one layer of a meltblown web, a bonded carded web, or other suitable material.

The nonwoven web outer layers may also be a composite made up of a mixture of two or more different fibers or a mixture of fibers and particles. Such mixtures may be formed by adding fibers and/or particulates to the gas stream in which meltblown fibers or spunbond fibers are carried so that an intimate entangled co-mingling of fibers and other materials, e.g., wood pulp, staple fibers and particles occurs prior to collection of the fibers.

Referring to FIGs. 9 and 10, the nonwoven thermal bond roller arrangement **108** preferably comprises a patterned calendar roller **110** and a smooth anvil roller **112**. One or both of the patterned calendar roller **110** and the smooth anvil roller **112** may be heated and the temperature of either roller and the pressure between the two rollers may be adjusted by well known means to provide the desired temperature, if any, and pressure to concurrently displace elastic layer **130** at melt bond sites, and melt bond the two outer layers together at a plurality of bond sites.

The patterned calendar roller **110** is configured to have a circular cylindrical surface **114**, and a plurality of protuberances or pattern elements **116** which extend outwardly from surface **114**. The protuberances **116** are disposed in a predetermined pattern with each protuberance **116** being configured and disposed to displace elastic layer **30** at melt bond sites, and melt bond the two outer layers together at a plurality of locations. One pattern of protuberances is shown schematically in FIG. 11. As shown, the protuberances **116** have a relatively small width, **WP**, which can be between about 0.003 inches and 0.020 inches, but in a preferred embodiment is about 0.010 inches. Protuberances can have a length, **LP**, of between about 0.030 inches and about 0.200 inches, and in a preferred embodiment has a length of about 0.100 inches. In a preferred embodiment, the protuberances have an aspect ratio (**LP/WP**) of 10. The pattern shown is a regular repeating pattern of staggered protuberances, generally in rows, each separated by a row spacing, **RS**, of about between about 0.010 inches and about 0.200 inches. In a preferred embodiment, row spacing **RS** is about 0.060 inches. The protuberances can be spaced apart within a row by a protuberance spacing, **PS** generally

equal to the protuberance length, **LP**. But the spacing and pattern can be varied in any way depending on the end product desired.

As shown in FIG. 10, patterned calendar roller **110** can have a repeating pattern of protuberances **116** which extend about the entire circumference of surface **114**. Alternatively, the protuberances **116** may extend around a portion, or portions of the circumference of surface **114**. Likewise, the protuberances **116** may be in a non-repeating pattern, or in a repeating pattern of randomly oriented protuberances. Of course, if randomly oriented, the opening of the resulting bond sites into apertures will also be somewhat random, depending on the orientation of the bond site with respect to the direction of tension, as discussed below. For example, if the web is tensioned in the cross-direction **(CD)** direction only, then the bond sites **50** having a longitudinal axis **l** with a vector component in the machine direction **(MD)** will open into an aperture, at least to the degree of the magnitude of such a vector component.

The protuberances **116** are preferably truncated conical shapes which extend radially outwardly from surface **114** and which have rectangular or somewhat elliptical distal end surfaces **117**. Although it is not intended to thereby limit the scope of the present invention to protuberances of only this configuration, it is currently believed that the high aspect ratio of the melt bond site **50** is only achievable if the protuberances likewise have a narrow width and a high aspect ratio at the distal end surfaces **117**, as shown above with reference to FIG. 11. The roller **110** is preferably finished so that all of the end surfaces **117** lie in an imaginary right circular cylinder which is coaxial with respect to the axis of rotation of roller **110**.

The height of the protuberances should be selected according to the thickness of the laminate being bonded. In general, the height dimension should be greater than the maximum thickness of the laminate web during the calendaring process, so that adequate bonding occurs at the bond sites, and only at the bond sites.

Anvil roller **112**, is preferably a smooth surfaced, right circular cylinder of steel.

After passing through nip **106**, the three (or more) component webs **120**, **130**, and **140** have been formed into unitary laminate web **10** that is elastic in at least one direction. In particular, the unitary laminate web **10** is elastic in the machine direction **MD**.

At this point in the process the outer layers are thermally bonded to each other by the high aspect ratio bond sites **50** and unapertured, as shown in FIGs. 1 and 2. Elastic layer **30**, from web **130**, is apertured, having been displaced by protuberances **116** in nip **106**. Depending on the elastic layer used, it may or may not participate in the bonding about the periphery of the bond sites. In some instances, particularly for non-thermoplastic, non-fibrous materials, elastic layer may not be involved in the bonding of the outer layers at all. However, for thermoplastic materials, and fibrous materials, some involvement of the elastic layer is observed.

Further, at this point in the process, if the elastic material **130** is elastic in the cross direction **CD**, the unitary laminate web **10** can be made elastic in the cross direction **CD** by extending the laminate web in the cross direction, which causes the apertures to form, as well as facilitating elastic extensibility. Such a web is not apertured, but can be apertured via tension in the cross direction, which tends to cause fracture of bond sites **50** that are then formed into apertures. This web is referred to herein a uni-directional elastomeric web, since it has elastomeric properties in the machine direction, even without being stretched in the cross direction to form apertures therein. Thus, the unitary laminate web **10** can be beneficially used in the unapertured condition exhibited at this point of the process as a unidirectional stretch material.

Although apertures can be formed in portions of web **10** simply by applying tension by any known method, including by hand, it is preferred to form apertures in the laminate web **10** in the whole laminate web by uniformly extending portions of the web in a direction orthogonal to the axis **l** of bond sites **50** (in the embodiments exhibited, the cross direction). As shown in FIGs. 9 and 10, the axis **l** is generally parallel to the machine direction **MD** of the web being processed. Therefore, extension in the cross-direction **CD** at the bonded portions causes the bond sites **50** to rupture and open to form apertures in the web.

One method for forming apertures uniformly across the web is to pass the web through nip **130** formed by an incremental stretching system **132** employing opposed pressure applicators **134** and **136** having three-dimensional surfaces which at least to a degree are complementary to one another. Stretching of the laminate web may be accomplished by other methods known in the art, including tentoring, or even by hand.

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However, to achieve even strain levels across the web, and especially if localized strain differentials are desired, the incremental stretching system disclosed herein is preferred.

Referring now to FIG. 12, there is shown a fragmentary enlarged view of the incremental stretching system **132** comprising incremental stretching rollers **134** and **136**. The incremental stretching roller **134** includes a plurality of teeth **160** and corresponding grooves **161** which extend about the entire circumference of roller **134**. Incremental stretching roller **136** includes a plurality of teeth **162** and a plurality of corresponding grooves **163**. The teeth **160** on roller **134** intermesh with or engage the grooves **163** on roller **136**, while the teeth **162** on roller **136** intermesh with or engage the grooves **161** on roller **134**. The teeth of each roller are generally triangular-shaped, as shown in FIG. 13. The apex of the teeth may be slightly rounded, if desired for certain effects in the finished web.

FIG. 13 shows a portion of the intermeshing of the teeth **160** and **162** of rollers **134** and **136**, respectively. The term "pitch" as used herein, refers to the distance between the apexes of adjacent teeth. The pitch can be between about 0.02 to about 0.30 inches, and is preferably between about 0.05 and about 0.15 inches. The height (or depth) of the teeth is measured from the base of the tooth to the apex of the tooth, and is preferably equal for all teeth. The height of the teeth can be between about 0.10 inches and 0.90 inches, and is preferably about 0.25 inches and 0.50 inches.

The teeth **160** in one roll can be offset by one-half the pitch from the teeth **162** in the other roll, such that the teeth of one roll (e.g., teeth **160**) mesh in the valley (e.g., valley **163**) between teeth in the mating roll. The offset permits intermeshing of the two rollers when the rollers are "engaged" or in an intermeshing, operative position relative to one another. In a preferred embodiment, the teeth of the respective rollers are only partially intermeshing. The degree to which the teeth on the opposing rolls intermesh is referred to herein as the "depth of engagement" or "DOE" of the teeth. As shown in FIG. 13, the DOE, **E**, is the distance between a position designated by plane **P1** where the apexes of the teeth on the respective rolls are in the same plane (0% engagement) to a position designated by plane **P2** where the apexes of the teeth of one roll extend inward beyond the plane **P1** toward the valley on the opposing roll. The optimum or effective

DOE for particular laminate webs is dependent upon the height and the pitch of the teeth and the materials of the web.

In other embodiments the teeth of the mating rolls need not be aligned with the valleys of the opposing rolls. That is, the teeth may be out of phase with the valleys to some degree, ranging from slightly offset to greatly offset.

As the laminate web **10** having melt bonded locations **50** passes through the incremental stretching system **132** the laminate web **10** can be subjected to tensioning in the **CD** or cross-machine direction causing the laminate web **10** to be extended in the **CD** direction. Alternatively, or additionally, the laminate web **10** may be tensioned in the **MD** (machine direction). The tensioning force placed on the laminate web **10** can be adjusted (*e.g.*, by adjusting DOE) such that it causes the melt bonded locations **50** to separate or rupture creating a plurality of apertures **60** coincident with the melt bonded locations **50** in the laminate web **10**. However, portions of the melt bonds of the laminate web **10** remain, as indicated by portions **62** in FIG. 4, thereby maintaining the laminate web in a coherent, unitary web condition even after the melt bonded locations rupture.

After being subjected to the tensioning force applied by the incremental stretching system **132**, the laminate web **10** includes a plurality of apertures **60** which are coincident with the melt bonded regions **50** of the laminate web. As mentioned, a portion of the circumferential edges of apertures **60** include remnants **62** of the melt bonded locations **60**. It is believed that the remnants **60** help to resist further tearing or delamination of the laminate web. Remnants **62** may also contain portions of elastic layer **30**, to the extent that the elastic layer is involved in the bonding.

Instead of two substantially identical rolls **134** and **136**, one or both rolls can be modified to produce extension and additional patterning. For example, one or both rolls can be modified to have cut into the teeth several evenly-spaced thin channels **246** on the surface of the roll, as shown on roll **236** in FIG. 14. In FIG. 14 there is shown an enlarged view of an alternative incremental stretching system **232** comprising incremental stretching rollers **234** and **236**. The incremental stretching roller **234** includes a plurality of teeth **260** and corresponding grooves **261** which extend about the entire circumference of roller **234**. Incremental stretching roller **236** includes a plurality of teeth **262** and a plurality of corresponding grooves **263**. The teeth **260** on roller **234** intermesh with or

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engage the grooves **263** on roller **236**, while the teeth **262** on roller **236** intermesh with or engage the grooves **261** on roller **234**. The teeth on one or both rollers can have channels **246** formed, such as by machining, such that regions of undeformed laminate web material may remain after stretching. A suitable pattern roll is described in U.S. Patent No. 5,518,801, issued May 21, 1996, in the name of Chappell, et al., the disclosure of which is incorporated herein by reference.

In certain embodiment wherein the axis **l** of bond sites **50** is oriented generally parallel to the cross-machine, **CD** direction, the incremental stretching can be achieved by use of mating rolls oriented as shown in FIG. 15. Such rolls comprise a series of ridges **360**, **362**, and valleys, **361**, **363** that run parallel to the axis, **A**, of the roll, either **334** or **336**, respectively. The ridges form a plurality of triangular-shaped teeth on the surface of the roll. Either or both rolls may also have a series of spaced-apart channels **346** that are oriented around the circumference of the cylindrical roll. Rolls as shown are effective in incrementally stretching a laminate web **10** in the machine direction, **MD** if the axis **l** of bond sites **50** is oriented generally parallel to the cross-machine, **CD** direction of the web as its being processed.

In one embodiment, the method of the present invention can comprise both CD and MD incremental stretching. This method is particularly useful if bond sites **50** are oriented in two or more directions, such as in a herringbone pattern. As shown in FIG. 16, two pairs of incremental stretching rolls can be used in line, such that one pair (**232**, which, as shown in FIG. 16 includes a series of spaced-apart channels **246**) performs CD stretching, and another pair, **332** performs MD stretching. By this method many interesting fabric-like textures can be made. The resulting hand and visual appearance make such fabric-like webs ideal for use in elastic articles benefiting from a fabric-like look and feel.

The elastic laminate webs of the present invention may be utilized in many varied applications. For example, the relatively low cost of nonwoven and film materials makes the laminates ideally suited for disposable articles, such as disposable diapers. The elastic laminate web can be used for the elastic waist or side panel portion of such diapers, for example. A preferred diaper configuration for a diaper in which elastic laminates of the present invention can be used as elastic waist or side panel portions is described generally

in U.S. Pat. No. 3,860,003, issued January 14, 1975 to Buell. Alternatively preferred configurations for disposable diapers are also disclosed in U.S. Pat. Nos. 4,808,178 (Aziz et al.); 4,695,278 (Lawson); 4,816,025 (Foreman); 5,151,092 (Buell et al.), all of which are hereby incorporated herein by reference.

In addition to disposable diapers, various embodiments of elastic laminates of the present invention are useful for use in other disposable absorbent articles, such as catamenials, panty liners, pull-up diapers, adult incontinence products, and the like.

The elastic web of the present invention is also useful for use as stretch fitting upholstery and furniture covers. The beneficial soft, fabric-like look and feel, together with elastomeric properties, makes the web of the present invention a low cost, semi-durable alternative to knits and woven products. In one embodiment, a mattress cover comprises a uni-directional stretch elastic laminate. The elastic laminate web **10** of the invention can be sewed onto a mattress cover in such a manner so as to provide elastic tensioning at the corners, or about the entire periphery of the mattress. In one embodiment, the entire mattress cover can consist of an elastic laminate web **10** of the present invention.

Other uses for laminates of the present invention include medical dressings; articles of apparel, such as medical gowns and garment sleeve cuffs; bandages, textured wall coverings, and the like. In general, any application of elastics in apparel, durable garments, disposable articles, furniture coverings, sports equipment, and the like are possible applications of elastic laminate webs of the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.